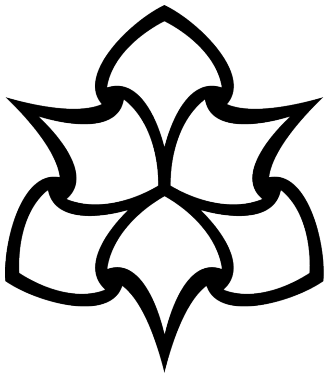

# Examples of the Impact of Collaboration in Creative and Technological Practices

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## ABSTRACT

*Over recent years the creative industries have continued to flourish, especially in the UK, where its economic growth and impact has bucked trends of national decline. One of the most identifiable characteristics of the creative industries is the range and diversity of people who work in the field. As such, it includes employees from many disciplines working in collaboration to achieve organizational goals. It is this creative collaboration, with a rich level of technological support in the background, which is the focus of discussion. An analysis of collaborative practices is delivered, followed by the formation of a model that attempts to capture and explain the relationship between the key features. This model is then applied as a lens to a small case study of 63 technology-related employees' perceptions of their employer in three successful companies who were in the top 5 of the 2017 Fortune 500 list, with the intention of determining how well their experiences map to the model. It was found that the six characteristics of the model were evident in each of the three organizations studied, but that one feature, organizational support, seemed to be more prevalent than the others. Consideration, via a second case study, is then given to creative multidisciplinary work, specifically in the field of crowd-accelerated development and the factors that surround it, leading us to devise a set of recommendations as to how future successful creative collaborations might be assessed and valued, along with a discussion of questions that have been identified for additional research and exploration. This is an extended version of a paper published at the Cyberworlds 2015 international conference.*

Keywords: Creativity, Enabling Technology, Virtual Environments, Online Collaboration, Multi-disciplinarity, Creative Teams, Crowd-accelerated Development, Social Media, Metadata.

## INTRODUCTION

*"Nothing new that is really interesting comes without collaboration"* (Watson, 1968)

This work explores the opportunities and experiences that occur in multi-disciplinary scenarios where the product of collaboration fits broadly within a definition of the creative industries. The primary focus is upon the real world implications and incidents of integrating people and practice across two axes: creativity and technology.

Moore's Law implies that overall processing power for computers doubles every 1.5-2 years, or less. A similar rate is also observed for telecommunications bandwidth. Although a general guide rather than a

fundamental law, it has proved remarkably consistent since the implementation of the first semiconductor integrated circuit in 1960.

Extrapolation, confirmed by expert evaluation of the technologies, confirms that for the immediate future, Moore's Law indicates that computational power will continue to increase at current rates, bringing more speed and capacity to handle more sophisticated applications and end-user requirements. It enables online collaboration to take place in a seamless and instantaneous manner, and at lower cost.

Where a variety of inputs are needed from different disciplines in order to further a research area, mechanisms for collaboration are necessary. In addition, the norms, concepts, and practices of research in each discipline need to be understood across the boundary. Multi-disciplinary, inter-disciplinary, and trans-disciplinary research, are identified by Holzbaur *et al.* (2012) as different aspects of collaboration across boundaries.

Page (2008) claims that cognitive diversity enables groups to find better solutions and also facilitates finding solutions when the problems are complex. Thus collaboration across discipline boundaries may yield more groundbreaking results than collaboration within a discipline.

The aim of this article is to present and analyze key metrics of features that form creativity in creative industries by drawing upon existing models from the world of business with the intention of establishing the extent to which these manifest themselves in creative multidisciplinary scenarios. Furthermore, we intend to provide insight into where these developments are likely to develop and evolve, principally via the use of social media and Internet-based technologies that allow enhanced engagement and acceleration of creative activity.

## Definition of Key Terms

Where a variety of inputs are needed from different disciplines in order to further a research area, then mechanisms for collaboration are necessary. In addition, the norms, concepts, and practices of research in each discipline need to be understood across the boundary.

In this work, we define *creativity* as being the ability of an individual to analyze a problem or challenging situation and to devise some form of solution or intervention in response that demonstrates elements of novelty or 'thinking outside the box' (Runco and Jaeger 2012). For example, creativity may manifest itself in response to a problem where existing solutions are no longer viable or constraints prevent their application, and so a new method of responding is required.

Many governments and international organizations produce their own definition of the creative industries. We refer to the *creative industries* as being a broad set of discrete disciplines or domains whose core activities are related to the application and dissemination of creative practice. As researchers in the UK, our particular approach is led by the UK Government's definition of the creative industries, which are focused upon the creative ability and related skills of individuals in being able to produce economic benefit and intellectual property through their work (DCMS 2010, Lee 2014). Specifically in the UK there are 9 sectors representing the creative industries: "*Advertising and marketing; Architecture; Crafts; Design; Film, TV and Radio; IT, Software and Computer services; Museums, Galleries and Libraries; Music, Performing and Visual Arts; Publishing*" (Bazalgette 2017).

Finally, *multidisciplinary*, plays an important part in much of the work that we discuss in this article. We consider multidisciplinary to be the coming together of individuals with one, or more, specific discipline base and skillset in a team of people from other discipline-specific backgrounds (Jackson 1996, Oborn

and Dawson 2010). These multidisciplinary teams are likely to work on a particular problem or project. This may be for a specific or indefinite period of time. The terms *multidisciplinary*, *interdisciplinary* and *trans-disciplinary* are identified by Holzbaur *et al.* (2012) as representing different aspects of collaboration across boundaries.

## CREATIVITY IN BUSINESS

Amabile (2011) explores a number of concepts of creativity and innovations and their place in the structure of businesses. This work explores the environments created by business managers and how creativity responds, or fails to respond, accordingly. Amabile states that the majority of managers have a somewhat narrow view of creativity: equating it with the imagination with which they solve problems. This is argued as being only one facet of creative behavior. While it is accepted that imaginative thinking is a part of creative behavior, it is argued that expertise and motivation are just as critical.

Amabile describes how the skills at the disposal of the practitioner are also dependent on personality, stating that the practitioner will be more creative if the practitioner is comfortable disagreeing with others, naturally attempting solutions that go against the status quo. Creativity is also increased if the practitioner combines knowledge and practice from other disciplines to find solutions. Two strategies for creative success are briefly mentioned: *perseverance* through a difficult problem until a creative output is achieved, and *incubation* in which a problem is set aside temporarily and returned to later with fresh perspective.

Expertise is described as encompassing the sum knowledge of everything that the practitioner possesses regarding their broad field of study. The skill with which the creative practitioner exercises their ability to solve creative problems is of key importance, but does not lie solely within the specific field in which the problem appears to lie.

The third factor in creative behaviors is motivation: the factor that determines what the practitioner will or will not actually do. Amabile goes further and classifies motivation into two types: intrinsic and extrinsic.

Amabile conducted experiments, interviews and surveys to allow insight into the creative behaviors taking place in businesses. Six categories presented themselves as key to the enhancement or diminution of creativity:

1. Challenge;
2. Freedom;
3. Resources;
4. Work-Group Features (Team-working);
5. Supervisory Encouragement;
6. Organizational Support.

A more detailed discussion of each of the features can be found in Earnshaw *et al*. (2015). These six features will be utilized to reflect upon the authors' experience of collaborative, creative environments.

## CREATIVE AND TECHNOLOGICAL COLLABORATION: ADDRESSING THE CHALLENGES

Amabile's categories (2011) will now be examined within the context of multi-disciplinary, technology supported, collaborative environments. The assumption is made at this point that each of the individuals within any creative team is already able to exhibit the necessary traits of creativity, expertise and

motivation, allowing the discussion to focus upon placing the six issues in the scenario of a project or business team:

## Category One: Challenge

A multi-disciplinary team will often consist of practitioners that possess a range of complementary skills, which, when working in harmony with one another, allows the breadth and depth of challenge for the team to be significantly increased over that of an individual.

One matter that must be considered by the task supervisor or manager, however, is the overlap of roles and responsibilities in the team. A good, interlocking, multi-disciplinary team will often exhibit skills 'bleed', where an individual's expertise integrates with another. Typically, this will come from previous experience of working with others in a team, as well as having to take on adjacent roles when working in smaller teams and on less well-resourced projects. Key to dealing with this issue is the distribution of clear delineations and responsibilities within the team. This strategy manages the challenge of matching the person to the task, as well as ensuring that the challenge is within the range of each team member.

Although not technological innovations that directly influence the level or nature of the team challenge, the evolution of online tools for managing and tracking the progress of projects has become commonplace in the majority of creative and technological industries. In particular, the adoption of online task managers and issue tracking systems have replaced paper counterparts and permit teams to work at a distance from one another or whilst on the move. Using technology to mediate task tracking and actively incorporating increased task completion and quality of engagement targets has led to a distinct field of gamification in business emerging in recent years (Deterding 2012, Kumar 2013), especially in mission critical aspects, such as business intelligence (Miller *et al.* 2016). This is coupled with other research by authors such as Kalinauskas (2014) and Roth *et al.* (2015) who recognize the limited amount of knowledge in this field and are specifically investigating the role that gamification might play in more creative endeavours, such as engagement with the creative process and idea generation.

## Category Two: Freedom

The main risk in providing creative freedom to multi-disciplinary teams is that the team may become fractured or, worse, that a team breaks apart to the extent of failing to meet the project aims. Such fracturing may be attributable to poorly defined aims, as recognized by Amabile (2011) or through misinterpretation by individuals or sub-groups within the team. As such, effective communication mechanisms and ensuring shared understanding are crucial in managing this risk. Similarly, the methodology or creative approach that the team adopts must be one that is understood and involves all disciplines.

Intuitively, this risk seems likely to be exacerbated when dealing with teams working remotely from one another. However, in recognizing that participants are to be remote, a good manager will engineer sufficient milestones and virtual or real meetings to track progress. Furthermore, the use of technology such as email, electronic conferencing, and so on, ensures that there is a clear audit trail. To this extent, there is no reason to believe that remote participants in a project are more likely to suffer fracturing, provided that adequate project management tools are put in place.

## Category Three: Resources

In considering the management of resources, a supervisor or manager must be aware of the broad range of resources and expectations that will feature within each of the disciplines that constitute the group. Those from more technically inclined disciplines will typically have a minimum level of expectations that they

will be uncomfortable to deviate from, whilst those from artistic or media communication disciplines are typically prepared to improvise or scale their performance relative to available resources. Effective communication is necessary again to ensure that all understand the distribution of resources within the team, so that favoritism and demotivation risks are minimized.

## Category Four: Work-Group Features

Intra-team support can be difficult in multi-disciplinary teams, especially where there are different backgrounds of reporting, methodology, and culture. Lack of support can often occur due to instincts of self-preservation or lack of understanding about the other disciplines involved. As such, this requires an honest and trusting environment and culture.

While acknowledging the need for honesty in discussion of creative projects between creative individuals, Catmull (2014) proposes a linguistic shift in terminology from honesty to candour. Honesty is a concept that is bound to a sense of morality that supersedes the truth. Candour as a concept is similar enough to the concept of honesty that honest and candid feedback are essentially the same, however candour allows for a lack of reserve and a departure from the morality of right and wrong. A strategy for countering the fear of the critique is establishing that the feedback is based upon empathy for the process and the creator. By making clear that the intention of the feedback is to construct possibility, rather than destroy potential.

Ensuring sufficient motivation of everyone concerned in a team is necessary to manage this situation. Similarly, an established team dynamic and mutual confidence amongst team members is essential. Multi-disciplinary team dynamics can be likened to the established models of cultural integration, such as a melting pot or a salad bowl (Samovar *et al*., 2011). Given this current collaborative issue, and those previously discussed, we advocate that an effective team integration model for multi-disciplinarians is more akin to that of a soup, specifically a broth, which allows the constituent disciplines to retain their form and specificity, but whereby they are bound together in a common situation and purpose, greater than the sum of its parts. This is supported by Rodríguez-Sánchez *et al.* (2016) who, through undertaking a large-scale study of creative teams, found compelling evidence that strong team cohesion leads to increased performance or productivity and this this is a cyclical, or snowballing, phenomenon, where cohesion increases again following performance success, and so on.

## Category Five: Supervisory Encouragement

The range of disciplines and technologies present may be inhibitive and even found to be obstacles by team supervisors and managers. This is likely to impact upon their capacity both to praise and criticize, although the latter is more likely for fear of otherwise not being seen to be in control of the team or lacking the necessary knowledge. Equally, over-praise for work that is not understood is misplaced.

The use of technology, and potential contribution of technologists, in creative teams presents an interesting opportunity for creative solutions to be tested, piloted, and ideally proven, before their actual implementation. This can be achieved through the use of mock-up, rapid prototyping, simulation, and so on. In this regard, a multi-disciplinary team may be able to offer supervisors and managers greater levels of reassurance, likely resulting in more praise and reward, throughout the project, rather than when the solution is deployed in the wild. This unique opportunity provides supervisors with mechanisms by which they can be informed by the progress of all disciplines within a team.

In recent work, Mailhot *et al.* (2016) discuss the role that leaders plays in collaborative research scenarios, specifically suggesting that a function of a leader in such situations is not only to motivate and direct the team, but also to ensure that each cognate group of workers within a multi-disciplinary team has

to be engaged in the project in terms that they can relate to. As such, it is suggested that people in these teams may not share "...a common vision…" and that the role of the leader is to translate the project requirements with each discrete group of people in a way that focuses them. In addition, the authors suggest that leadership within such scenarios works well in a distributed fashion over the entire project, rather than one person trying to oversee the whole enterprise.

The work of Mailhot *et al.* was based upon case study observations of a collaborative project focused upon an educational development, rather than on a creative project, and one that included public and private sector participants, as well as those from varying disciplines. However, the broad principles are interesting and worth consideration. To this extent, the role of the leader of a collaborative team might be likened to that of a Systems Analyst in the Information Systems domain of computing and computer science. It would therefore follow that a team leader should possess, or at least have an appreciation of, the set of skills, expectations, and mind-set that each group within the team possess. This suggestion is one that resonates with the work of Mitchell *et al.* (2017), who found that trans-specialist knowledge improved the ability of members of a collaborative team (notably not the leaders), in a health professional scenario and utilising debate within the team, to be innovative. It is reasonable to expect that such trans-specialist or trans-disciplinary capability is likely to be fruitful whether in a team member or team leader.

## Category Six: Organizational Support

As with all effective organizations and cultures, leading by example and embedding core values is essential. The major risk in adopting a multi-disciplinary strategy at an organizational level is that the organization may appear, to external parties, to be fragmented. However, there are many large and successful organizations in the creative industries that incorporate this model and so it may be argued that the issue is one of scale and therefore resources.

## A Functional Model

It is worth noting that Amabile's six categories portray themselves as being embedded across and throughout the organization. In forming a working model of these factors for example, it is difficult to separate out the organizational and managerial aspects from those of the team. Whilst it seems that Amabile recognizes these as separate actors within the organization, there is no hard barrier between them. For example, embedding Freedom and Resources into creative practice requires management endorsement, though not necessarily on an active level but one that is more passive. Supervisory Encouragement and Organizational Support, on the other hand, are more active in nature. However, it is hard to detach any of the six features completely from some kind of management structure. This leads us to attempt to present a functional model of Amabile's six categories and this is illustrated in Figure 1.


*Figure 1. Translation of Amabile's Six Key Factors into a Functional Model*

This model is helpful initially to demonstrate which of the factors are predicated upon the organization and management, and hence form part of the creative environment, shown in a circular arrangement, around the creative team and practitioners, indicated as being in the center of the diagram. To this extent, we bring Amabile's model to life further and also highlight a possible limitation, in that the majority of these factors are within the control of the organization and management, rather than the practitioners themselves. This said, we would strongly advocate that Freedom, Challenge and Resources should effectively become culturally embedded within the creative organization and hence ownership taken fully by both creative practitioners and management.

It may be harder for a small creative enterprise to demonstrate effectiveness and purpose, if it does not have a focused and deliberate set of limited disciplinary directions. However, technological advances allow for contractors and freelance workers to be brought in and integrated into a project or team with greater ease, notwithstanding the previously discussed issues.

A good example of creative multi-disciplinarily working can be found in Earnshaw *et al*. (2015), which is particularly focused upon the adoption of crowd-accelerated development (Anderson 2010) as a catalyst. We find that the use of technology in this situation is particularly powerful in intensifying the effects, especially engagement, are intensified.

## ANALYZING THE FUNCTIONAL MODEL IN PRACTICE: A CASE STUDY

### Rationale

Amabile (1998) presents brief case studies from a larger research process (Amabile, Mueller and Archambault 2003) that identifies elements of the six categories in several business scenarios. This work was undertaken over a period of two years and followed multiple teams in seven companies across three sectors. It is reported that the process of capturing data, in confidence, relating to creativity in the workplace is undertaken by asking for daily email reports and utilising reports from company experts and team members to assess creativity factors at the end of defined projects that had been carried out. Amabile's (1998) report upon these case studies is now almost 20 years old. In this work, we apply a

smaller scale application of these principals to determine the role that creativity, according to the six categories, is playing in current organisations, which are subject to the technologically ubiquitous and social media aware world that today surrounds all business.

## Methodology

To undertake this study, we decided to study the field of software engineering and development in three companies from the top 5 of the 2017 Fortune 500 list (2017): *Walmart*; *Apple*; and *Exxon Mobil*, representing positions 1, 3, and 4 of the Fortune 500 list. *Berkshire Hathaway*, who are position 2 in the list were discounted as insufficient software development data could be sourced using the methodology of this study.

Taking influence from Amabile's (1998) methodology, it would be necessary to extract some form of account or report from employees at these companies in order to assess the role that the six creative categories might be present in these organisations. To do this, the recruitment website Glassdoor (https://www.glassdoor.co.uk/index.htm) was utilised, since it provides the facility for employees to post reviews of their experience of working for an organisation and data is publicly available to anyone who creates an account on the website. It promotes the service as being completely anonymous to encourage individuals to be honest about their experiences.

Using this facility searches were conducted for each of the three companies selected and then additional filters were applied to select only full-time workers. After some initial inspection of the remaining data, decisions were made about roles to select that provided a broad representation from software engineering or software development functions within that organisation. These occupations require a mixture of creative and technical skill, as there are often problems to be analysed and solved, systems and solutions to be designed and evaluated, and then fully implemented and engineered into viable and robust products. Furthermore, these roles will frequently rely upon team interaction and collaboration with other roles, some around the creative and design ends of the spectrum and others at the more technical and computational end. The exact nomenclature varied slightly between each of the organisations but the intention was to identify reviews at a worker level (for example, software developer, software engineer, and so on) and at a team leader, middle management level (senior software developer, software supervisor, IT manager, and so on). A summary of search terms and number of reviews identified for each of the three organisations is provided in Table 1.

*Table 1. Search Terms Used and Number of Results Obtained in the Case Study*

| **Organisation** | **Workers** | | **Middle Managers** | | **Total** |
|---|---|---|---|---|---|
| | **Search Term** | ***n*** | **Search Term** | ***n*** | |
| Walmart | *Software Developer* | 11 | *Principal Software Engineer*<br>*Senior Software Engineer* | 2<br>12 | **25** |
| Apple | *Software Developer* | 17 | *Software Supervisor*<br>*Team Lead Software* | 1<br>1 | **19** |
| Exxon Mobil | *Software Developer* | 6 | *IT Manager* | 13 | **19** |
| **Total** | | **34** | **29** | | **63** |

After conducting these searches, each of the 63 reviews was analysed by one of the paper authors (for consistency of interpretation this was the same person) and appropriate statements from each review were attributed to one of the six categories. Each statement was then appraised of its valence: being positive or negative. This was typically a straightforward process since the majority of review contents are presented

under the headings of "Pros" and "Cons" on the Glassdoor website. This allowed a descriptive picture to begin to be composed of experiences of employees at each organisation, with respect to the six categories.

## Data and Results

As additional context to the comments left in reviews, the Glassdoor website also provides employees with the opportunity to rate their employer on a scale of 1 to 5 stars (a higher number of stars indicating increased satisfaction). The overall summary ratings for each of the organisations studied in this article are shown in Figure 2 and correspond to the numbers of workers and middle managers identified in Table 1.

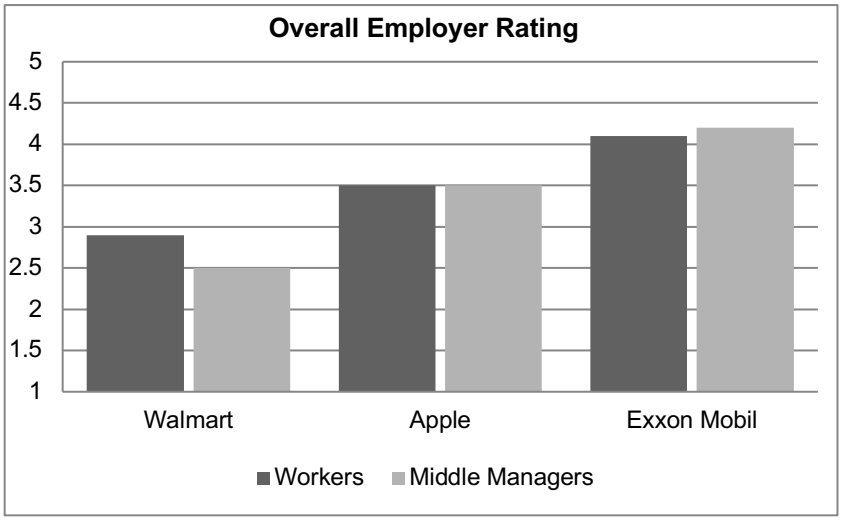


*Figure 2. Ratings of Organization by Employee Level*

These quantitative figures may provide a useful background to the perception of the employees whose data was then further scrutinised in detail relating to the six categories of creativity. A summary of the distribution of the number of employees who made positive and negative comments across the six creative categories is shown in Figure 3.

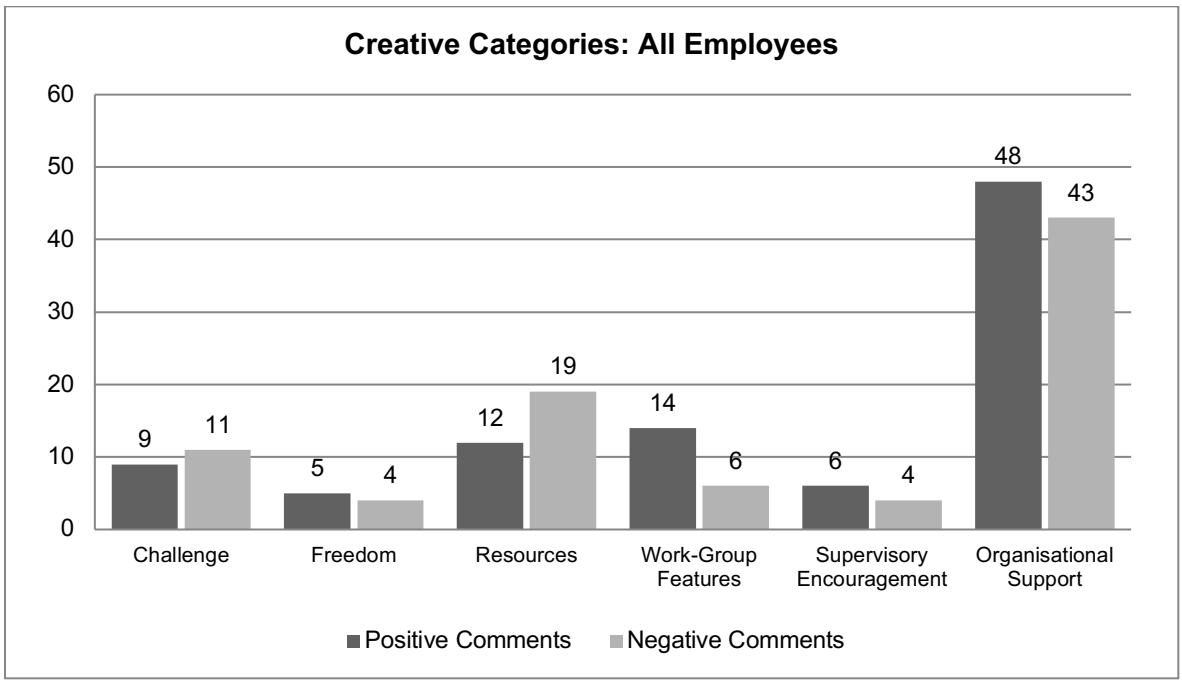


*Figure 3. Distribution of Employee Comments in Amabile's Six Categories*

In terms of the number individuals who made comments made across each of the six categories, it was notable that the smallest numbers of comments were received in the categories of Freedom and Supervisory Encouragement.

Positive comments around the category of Freedom related to themes of the organisation being open to providing employees with empowerment to make choices and to experiment, as well as having the ability to move between different areas. Such themes are encapsulated well by one particular account, which has resonance with some of those reported by Amabile (1998): "*empowerment, making mistakes is actually encouraged*". In terms of negative comments, these related to the absence of employee flexibility, technical choices, and their ability to make agile decisions.

Regarding the category of Supervisory Encouragement, positive comments related to aspects of management and supervisors generally being 'good' and, particularly, several individuals commented about the fact that they felt supported by their supervisors. It is interesting to note that there were no comments specifically around the aspect of encouragement, which, it might be argued, it a much more proactive managerial activity than providing support. Negative comments relating to this category were broadly around not feeling looked after or from additional work being unrewarded or having promises made by their managers that were not followed through upon. For example, one employee stated: *"...I worked in the management line of work, and they really don't pay anything, unless you have connections. They move you to a high position, however your pay scale stays the same*".

It is worth noting at this point that a number of employees made comments about the general leadership and management of the organisation. However, the majority of these comments related more to the culture or strategy of the organisation and hence they were categorised into Organizational Support, which was also where the largest, and most significant, number of comments was received. The positive valence themes encountered in this category generally related to the various benefits and "*perks*" offered by the organisation, the general work environment encountered, and the scope and impact of working for a large-scale organisation (which is to be expected given that the companies selected are in the top of the

Fortune 500 ranking). Negative comments pertained to themes of the organisation being too slow in progressing, poor communication, lack of communication, issues of recognising hard work, and appraisal processes.

To explore each of the three organisations Figure 4, Figure 5, and Figure 6, show more detailed distributions of the number of participants making comments in each of the six categories and also provides differentiation between the comments made by workers and those in middle management roles.

Walmart

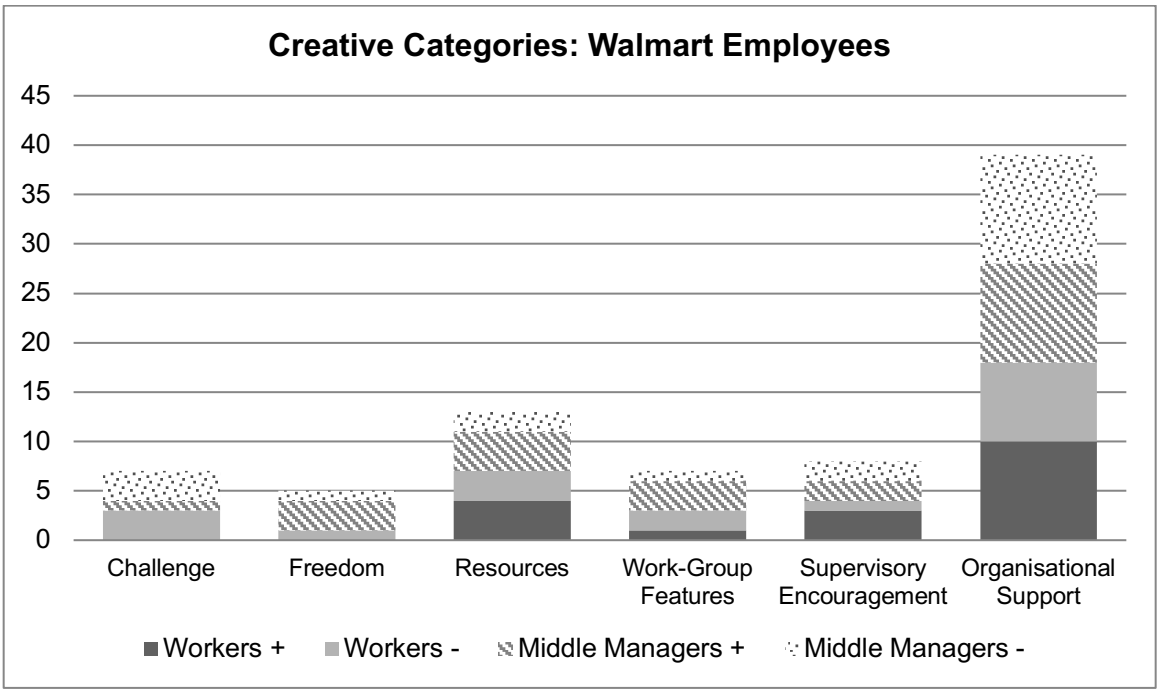


*Figure 4. Distribution of Walmart Employee Comments in Amabile's Six Categories*

Worker level employees at Walmart did not provide any positive comments relating to Challenge, whilst one middle manager stated that "*Work is challenging, the opportunity is real and impact people are having is huge. Many good technologies to master to solve big data, large scale problems*". Both workers and managers commented upon negative aspects around being able to learn new things and the work being "*slow*".

No positive comments around Freedom were made by workers, whilst three managers comments upon there being flexibility, freedom to choose technologies, and there being scope for experimentation. Negative comments were "*Please include agility in work processes*", from a worker and "*No flexibility to learn new things*", from a manager.

Regarding Resources, all of the positive comments from workers, and one from a manager related to the quality of work-life balance. Other positives from managers described the quality of technologies available to work with. As an interesting contrast, all of the negative comments from workers, and one from a manager related to technologies being "*old*" or absent. One manager commented upon the poor work-life balance, again, in contrast to the positive comments to this effect: "*Poor Life/work balance 45+ hours per week plus out of hour support with no compensation*".

All positive comments as part of Work-Group Features related to the quality of employees: "*great minds*" and *"…really intelligent*" along with the general "*camaraderie among many teams*". Negatives related to competitiveness and individuals putting themselves before the team in comments from both workers and managers.

Regarding Supervisory Encouragement, both workers and managers were unanimous in their "supportive" managers and supervisors and the general niceness of their supervisors and this is a distinct theme within this organisation. The one negative comment from a worker reinforced the notion from Work-Group Features that their superior was putting themselves before their team. Both negative comments from managers were in relation to feeling suppressed or undervalued in their roles.

Finally, in Organizational Support almost all of the responding employees commented positively about the work culture, supportive environment, and the additional perks and benefits, such as free food and the vacation policy. The majority of workers made negative comments around the areas of organisation politics and the slow pace of work. This was supported by several managers, who also reported main themes of the organisation being averse to new ideas or ways of doing things and being very process intense, for instance: "*They make more red tape than they need…"*.

Apple

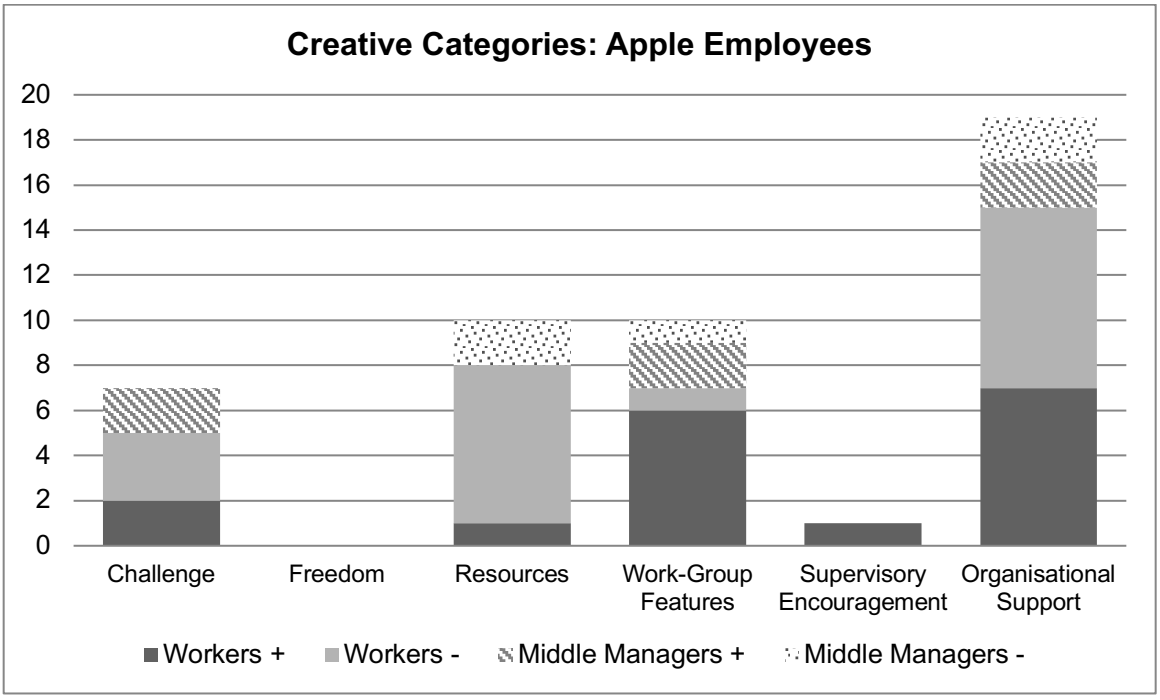


*Figure 5. Distribution of Walmart Employee Comments in Amabile's Six Categories*

Both workers and managers at Apple were unanimous in identifying positive Challenge aspects of their roles and making them feel stretched and pushed, but satisfied and fulfilled in their work. The following statement best exemplifies this: "*They throw real hard problems at you and you have to figure it out. When you do figure it out and you see the product/feature being used by millions of people, its extremely rewarding*". Negative responses from workers were around fast pace, tight deadlines, and stressful experiences. There were no negatives from managers in this category.

Interestingly and surprisingly, there were no positive or negative related comments provided in the category of Freedom for Apple employees.

There was only one positive comment relating to Resources from a worker, presumably quite new to the organisation, as suggested by the statement provided: "*No expectation to work ridiculous hours (though I'm sure crunch time will exist)*". This does seem contrary to the negative comments founds in both workers and managers who were extremely consistent in stating that the job required long hours and a lot of work to be done outside of official work time. For instance: "*No work life balance. I am expected to work 10hour days and literally every weekend*" and "*There was always more work to be done than time in the day*".

Work-Group Features featured positive comments from workers about the quality of the working environment and the other people around them, best summarised: "*nice people, good environment*". Managers too rated the strength and talent of the people around them. There were a small number of negative comments, one from a worker indicated that people in teams are competitive and put themselves before the team. One manager commented that some team members don't contribute, being "*...free riders*".

There was little response in the Supervisory Encouragement category. There was one positive comment that fit within this category, which may well have come from an intern or new hire: "*There is a good team in apple, the instructors always help and they always give you a really good service*".

Regarding Organizational Support, positive comments from workers and managers were largely about the working environment and culture, customer focus, the ability access and work with new technologies, and the added benefits and rewards offered by the organisation. Negative comments from workers were themed around secrecy and deficiencies around organisation and management.

Exxon Mobil

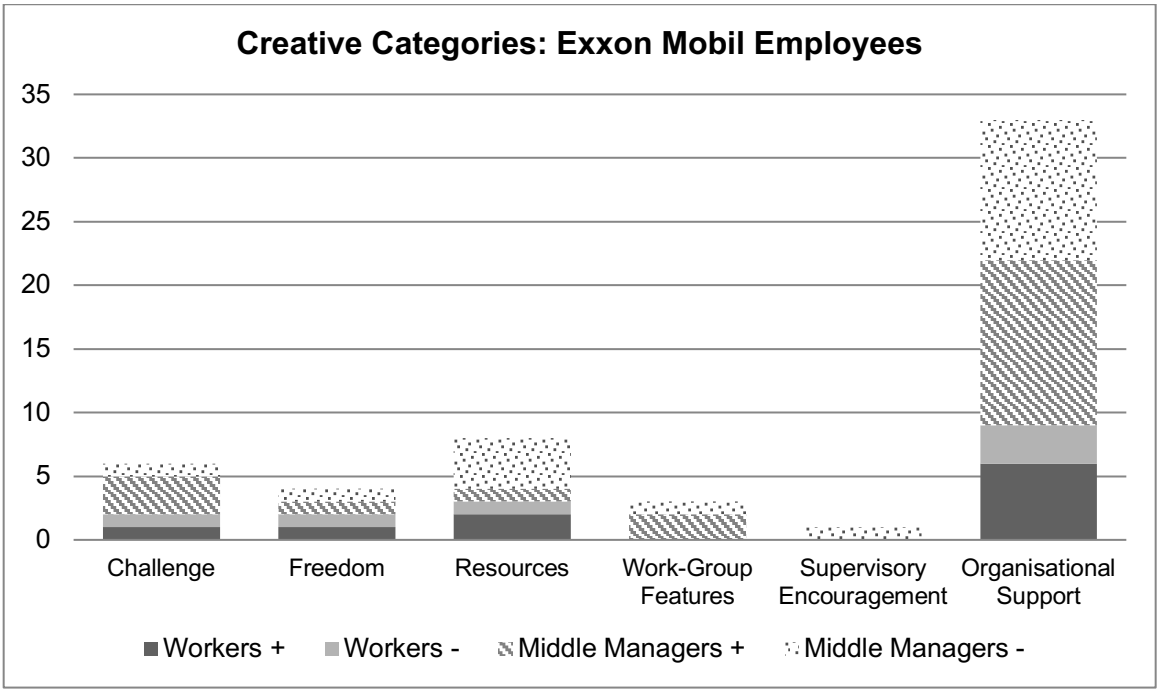

*Figure 6. Distribution of Walmart Employee Comments in Amabile's Six Categories*

In terms of the Challenge category both workers and managers commented upon "*Challenging opportunities*" and *"...problems are generally challenging/interesting*", indicating a consistent level of stretch being applied at both levels. The smaller number of negative comments related to the lack of technical challenges (worker) and that some roles can be over-taxing, resulting in *"... somewhat high stress depending on the role and current activities*" (manager).

Positive comments pertaining to Freedom described how there are opportunities to work in different areas and that experimentation and *"...making mistakes is actually encouraged*". One worker made the negative comment that they were not able to make technical decisions, whilst one manager made a negative remark about the inability to work to a flexible schedule, which might arguably be considered to be a resource issue than one of freedom.

When it came to the Resources category, workers reported positive factors relating to their workload and that they had a good work-life balance. This was supported by the one manager comment, stating: "*good work life balance as you progress your career*", which could also be indicative of positives in terms of Supervisory Encouragement or Organizational Support.

Supervisory Encouragement had a notable lack of responses. There were no explicit positive comments from workers or managers (notwithstanding the remark above in Resources). There was only one negative comment, from a manager, describing perceived issues of conflict and lack of transparency from their superiors relating to progression up the career ladder at Exxon Mobil.

Organizational Support received many responses. Workers who left positive comments were almost unanimous in praising the level of pay received from the organisation. Managers too reported positives around good pay, as well as non-monetary considerations such as job stability, opportunities for development, and additional employment benefits. Negative comments from workers were around the use of an employee ranking system and health and safety processes and policies that they perceived as being over the top. Managers too identified negative elements around the risk-averse nature of the organisation and the employee ranking system, perhaps best summarised by one comment: "*Forced ranking process, completely depends on 'who you know'... 'Nanny' safety policies - must hold handrails on stairs, etc*.".

## Limitations

There are several aspects of this work that must be considered when reviewing the results presented. Firstly, the accounts posted on the Glassdoor website are not verifiable as being from genuine employees of the organisation. This is likely to limit the validity and reliability of the data present and may also introduce a skewing of the information that is posted since, for example, it may be a way for disgruntled employees to 'vent' frustrations with their organisation, whilst content employees may have little motivation to post reviews. Second, the data posted on the website is, unlike Amabile's (1998) work not explicitly prompted with respect to aspects of creativity in the workplace. Rather, an attempt has been made to interpret the data posted and, where appropriate, attribute it positively or negatively to one of the six categories. The large number of comments being categorised against Organizational Support may be due to the nature of the Glassdoor website, which is ostensibly about employee experiences of working for the company, rather than being focused upon their experiences of working on a particular project. As such, the information presented here should be treated with healthy scepticism and as an initial evaluation of the state of these six categories in contained roles within each organisation, opening the door for future, larger-scale exploration, rather than attempting to derive any hard conclusions or findings from the data.

## Discussion of Results

It is interesting overall to note that not of all Amabile's (1998) six categories have a similar distribution of occurrence in the employee comments that have been analysed in this section. Organizational Support received the largest number of employees leaving positive and negative comments, whilst other categories received much less attention. Examining the distributions, those from Walmart and Exxon Mobil are broadly similar; fitting the overall trend of Organisational, Support being the dominant factor, whilst the comments from Apple employees see slight increases in discussion of Challenge, Resources and Work-Group Features as well.

Considering the earlier model synthesised from the six categories (Figure 1), the results here suggest that revision is required. Our earlier discussion of the categories lead to placing of Work-Group Features in the centre, as a core element, which we argued was appropriate since the individual and people that constitute the team are at the heart of creativity in practice. However, the results from the case study suggest that Organizational Support is a much more important feature. Indeed, in the overall set of results (Figure 3) Work-Group Features are the third most frequently remarked upon feature, with Resources taking the second place. This leads us to modify the presentation of Amabile's categories into a functional model, with Organizational Support now at the heart, being the enveloping feature, as shown in Figure 7.


*Figure 7. Revised Translation of Amabile's Six Key Factors into a Functional Model*

It could be tempting to apply a weighting to each of the categories presented in the model upon the basis of the result gained from our investigation. However, there are no categories that receive such a significant number of responses for each of the three organisations examined and we advocate that further, more detailed investigation would need to be undertaken to examine the presence of any weighting or hierarchy amongst these remaining factors. Nevertheless, the fit of Organizational Support in this position is a good reflection of the data analysed, suggesting that the overall environment, benefits and perks, organization, and management culture of the company have a much greater impact upon employee satisfaction.

## EVALUATING THE IMPACT OF CREATIVITY AND TECHNOLOGY – WHAT DOES SUCCESS LOOK LIKE?

So far in this work, we have discussed examples and models of situations where creativity and technology have come together to produce a notable outcome, one that would be unlikely to have occurred without that partnership of the two factors. Our analysis has considered the business, personnel, cultural, and technological factors likely to contribute to creative successes. However, this leads us to consider an important factor in any further success that is to evaluate the marriage of these two factors: how we can attempt to gauge and measure success in creative scenarios in any subsequent research of this field? This in itself is not an easy task, given the multi-faceted nature of the creative industries and the range of impacts and implications that creativity has on business and society as well as creative practitioners.

For example, it may be argued that a creative person's experience and perception of success in their accomplishments may precede or be latent with respect to a business stakeholder's experience of the same success. Indeed, it is entirely possible that creative and business successes may be mutually exclusive. Such an interrelationship may also exist between two or more combinations of other factors that are corollary to the purpose of the overall creative effort. To this extent, we present and discuss some of the key factors and considerations crucial to such an evaluation in an attempt to provide shape to any future investigation rather than devise a particular tool or metric, which may not be suitable for every scenario. The remainder of this section focuses on several of the most important fields where success should be measured: business, creativity and collaboration, technology, and society. The assumption is therefore made that creative and technological fusions under investigation have some business or organizational application. These are then brought together in a set of recommendations for future research that seeks to evaluate the performance of creativity and technology collaborations.

### Business

Success in the world of business is, in itself, a diverse and complex topic. However, all 'for profit' organizations exist only for so long as they are considered to be financially viable or have the potential to be financially viable within a defined, usually short-term, period of time. As such, it is natural to begin with such a quantitative base. Such Key Performance Indicators (KPIs) measures that immediately warrant attention are standard financial data such as profit, revenue, turnover, cash flow, and growth. There is appeal in this approach also from the perspective that measuring achievement in such a manner is tangible, easily communicated and understood. There are, however, natural limitations in using such measures when researching success and impact. In particular, a granularity of financial information will be required that allows the researcher to determine whether or not any creative, technological intervention made has actually been responsible for a financial performance change. Using high-level financial data is far too abstract, especially in large organizations. It is much more effective to consider these impacts and report them on a project or even departmental financial basis, thus permitting more confidence in the validity of any figures. Even then, it may be challenging to measure any longer-term impact other than an immediate or transient performance change.

Even so, organizations that exist for purposes other than profit engage with, and utilize, creative practitioners and technology. Certainly, many successful creative practitioners of the past gathered in collectives, groups, and co-operatives. Such a situation may experience a resurgence in years to come, as posited by some (for example, McRobbie, 2011). These factors necessitate wider views and metric of business success that reflect both the stakeholder interests as well as the ability to deliver the services or vision of the organization in question.

A number of frameworks for business performance analysis have been developed over recent years (Marr & Schiuma, 2003). A good example of this is the Performance Prism (Neely, Adams, & Crowe, 2001),

which attempts to include a range of performance and satisfaction criteria, including factors such as stakeholder satisfaction, strategies, policies, and capabilities. Across these categories sit a range of stakeholders, both internal and external to the organization, and so a wide-reaching analysis of the organization's performance can therefore be viewed. This range of factors requires a diverse analysis in any research activity and one that is primarily oriented around qualitative data and often based upon subjective information. As such, it necessitates a more time-consuming route of investigation and analysis, especially across so many factors. It is interesting to note, however, that work has been done to investigate the validity and appropriateness of subjective performance information in the world of business and, whilst this information is considered useful mainly as a secondary source, not to replace objective measures, it has been shown that it does provide helpful insights into business performance (Dess & Robinson, 1984). It is worth stressing that this particular set of results is concerned with measuring factors where both subjective and objective information is available and therefore the extension of this principle to factors where there may be no objective data is speculative. As an example, recent work investigating the impact of social media technology in a business-to-business (B2B) scenario, evaluated the use of this creative technology using metrics related to customer satisfaction, responsiveness, communication (Agnihotri, Dingus, Hu, & Krush, 2015). In that study, these were self-reported by the employees (sales representatives) using a Likert scale over a number of categories and questions. As such, this permitted the authors to conduct a quantitative analysis of this subjective information.

As such, we find that measures of business performance must embrace largely quantitative data types and necessitates the use of subjective and objective information, which may quickly become a complex web. In subsequent research, using business success factors as part of a broad analysis, it is worth focusing on a limited number of these measures and seeking to obtain a balance between the subjective and objective information that can be gathered.

## Creativity and Collaboration

The focus of this evaluation is likely to rest in two primary areas: the customer or consumer of the products and service that are being delivered by a creative process and the creative people involved within, and across, the organization(s) delivering them. As has been discussed earlier in this work creativity is a difficult thing to measure due to its transient and somewhat ethereal quality. It is natural then that the two stakeholder groups mentioned previously measures success in creativity and collaboration. As such, any measure of creativity and collaborative success will almost certainly be subjective in nature, but with the potential to take on either quantitative or qualitative form. Whilst the former may be a faster process in terms of data capture and analysis, by using Likert scales or similar, it is likely to only scratch the surface and provide superficial indication regarding features like level of creativity, perception of success, and so on. This approach then is best left to analyze the consumer or customer perception of creative practice and collaboration, since they are unlikely to have seen 'under the hood' of the process itself. As such, more detailed information is not likely to exist. To this extent, we advocate use of this kind of approach here.

In the case of the creative practitioners and professionals, the opportunity would be much better spent to obtain deeper insight by utilizing qualitative techniques such as interviews, questionnaires, and focus groups. Other research into creative processes has largely focused upon the analysis of individuals involved from a psychological and cognitive perspective, analysis of defined tasks, or self-reporting via questionnaires or surveys (Choi, 2004, Kratzer, Leenders & Van Engelen, 2006). In particular, this will not only allow perceptions of success and performance to be elucidated but should help identify particular causes or interventions that have allowed such changes to be realized. When considering the impact of collaboration upon creative teams there will be enhanced opportunity to investigate the particular relationships and influences that have contributed to performance upon particular projects.

## Technology

The success of a technology can be divided into two main strands: technical achievement and user perception. In short, technical achievement can be considered as how well a technology solves a particular problem or otherwise undertakes the function for which it has been designed. In contrast, user satisfaction considered the human factors relating to the technology such as how easily they find it to deploy the technology for its purpose or it could be their broad level of acceptance and adoption of the technology over a period of time.

Typical measures of technological problem solving relate to some kind of performance enhancement measurement. Often, this will equate to how quickly or concisely a given task(s) can be performed by the technology, usually by comparing to a known benchmark or current 'best' standard. Such measures are hard to generalize and will almost certainly be dictated by the type of technological intervention that is under scrutiny. It is very likely that any such series of measures will be quantitative in nature and drawn from objective measures, such is the nature of technical benchmarking exercises. This lends itself to ease of analysis from the perspective of speed, reliability and clarity of interpretation. Analysis of these metrics provides useful information, but especially being mindful that such research is concerned with multi-disciplinary and creative technologies, a more person-centered and subjective set of evaluation data is also required.

User perception data can provide the other half of this picture being sought. Drawing upon well-established practices and principles from the fields of product design, human-machine interaction (HMI), Human Computer Interaction (HCI), and User eXperience (UX), there are a range of measures available to gauge the success and human perception of a given creative technology. Such assessments are often conducted using a mixture of research approaches, largely as a result of the field itself being multi-disciplinary. However, most user assessments capture quantitative data that is based upon subjective user evaluation, whilst the remainder of research tends to be captured using qualitative information from mechanisms such as interviews, observations, and focus groups. There are some quantitative, objective evaluations, such as time-based exercises, but these tend to be in the minority of studies in fields, such as UX (Vermeeren, Law, Roto, Obrist, Hoonhout & Väänänen-Vainio-Mattila, 2010).

## Society

Measuring the impact of any intervention upon society is difficult. The diverse and complex nature of society itself presents many variables that are beyond the control of a single research investigation and may contribute to the cause of any changes that may manifest. This is perhaps the hardest challenge of measuring the impact of creative and technological processes and interventions. This complex area of research has been addressed by others, where qualitative interviews were used that focused on a number of factors that broadly sought to evaluate level of perceived change in the participants, with regard to their feelings of empowerment and transformation within the domain being investigated (Walter, Helgenberger, Wiek, & Scholz, 2007).

As a result, an extremely focused approach is likely to yield the most viable results and this may be achieved either through the careful selection of a sample from a particular social group and following them over a duration of time, namely via a longitudinal study. Alternatively, there may exist a natural group that would serve to be analyzed, particularly in the case of not-for-profit organizations and social enterprises, which are likely to serve a defined societal user group. Qualitative investigations via interviews and focus groups are likely to yield the most valuable results and will be based largely upon the analysis of subjective information.

## AN EXAMPLE OF CREATIVE MULTIDISCIPLINARY WORK: CROWD-ACCELERATED DEVELOPMENT

### Context

The traditional method of distribution within the creative industries means that many of the works that may be classed as innovative are only heard about long after the point of conception, upon release. If an innovation sits outside of the viewer's personal preferences when it comes to surface facets of the construction such as the aesthetic style, these innovations can be largely overlooked and therefore unheeded.

Anderson (2010) proposed the idea of crowd-accelerated innovation after observing the upward trend in innovative approaches to the lectures given at the TED conference that he curates. Anderson proposes that crowd accelerated innovation requires an existing community, that this community is visible to one another and that this community have a shared desire.

Giving these communities access to the innovative thinking of the individual (not necessarily the deployment or application of the concept or the final product) allows the community to access the innovation and expand upon it prior to the point of release or consumption, the publishing date. This access to innovation or innovative behaviors, prior to the point at which the project goes to press, refers directly to the acceleration. If the community only has access to the consumption point of the artwork, it may be inferred that this is 'regular' rather than accelerated innovation.

A key aspect of crowd-accelerated innovation is the ability through technology to intensify its effects. Anderson states that by increasing the size of the crowd through online social media with the ability to share creative work digitally, the fidelity with which the community may communicate and access to extended modalities for the sharing of media, crowd-accelerated innovation affords enhanced opportunities for innovative behaviors to take place and at an increased pace.

So, by increasing the size of the crowd and giving this inflated group of linked practitioners access to the insights and innovations of others, Anderson argues that the desire to continue engaging emerges naturally as part of intrinsic human behavior. The central thesis of Anderson's article argues that through the ability to share with an enhanced level of fidelity the insight and innovation of a group of creative practitioners, the rate at which the overall group innovates is increased. Similarly, Anderson stresses the importance of the ability for the community to share a variety of forms of media and enable the community to engage in discussion.

### Example: *Iron Sky*

A useful illustration of the crowd accelerated innovation process can be found in the film *Iron Sky* (2012), which highlights several of the issues and aspects of integrating a large community process into the development of a highly creative and multidisciplinary development process. The involvement of the crowd in *Iron Sky* permeated through the majority of all activities relating to the production, including many discipline features such as marketing, promotion, editing, acting, distribution and so forth. The project was highly successful in its aim of achieving the required resources necessary to realize the complete film over a period of several years.

One aspect of the development of *Iron Sky* was that, rather than develop its community involvement and engagement via crowd funding websites or existing forums and discussion boards, the production team developed their own platform to host the community's engagement, which was designed not just for *Iron Sky,* but to host any other similar project entitled Wreck A Movie, and presented as *"...a collaborative*

*tool for online film production*" (Joutsen *et al.* 2008). At the time of writing this article the Wreck A Movie platform is no longer functioning online.

As Anderson (2010) highlights, the engagement with the community and their ability to discuss and share ideas is a key factor in accelerating a development. However, in the case of *Iron Sky*, this community engagement and sense of freedom or ownership by the community also was a cause of difficulty or conflict for the team leading its production (Telo 2013, Vuorensola 2013). Particularly, Vuorensola (2013) described issues of having to balance the overall direction and timeliness of making the film against the varied suggestions and inputs of the community who felt that their engagement and funding of the project may have entitled them to degrees of creative control over the production. This resulted in clear boundaries having to be identified and managed during the process.

## RECOMMENDATIONS

As previous sub-sections have shown, the multifaceted nature of creative success demands methods of investigation and measurement that combine broad quantitative and qualitative research approaches. The use of triangulation between the two will be crucial. Much research data will rely upon self-reporting when working with quantitative measures, which in itself presents a threat to the validity of the research. This, however, can be brought into balance by the appropriate use of researcher-led, controlled investigative techniques such as semi-structured interviews, focus groups, and the earlier mentioned repertory grid technique.

Quantitative data can be analyzed and defined interventions measured using appropriate inferential statistics, hypothesis tests, and measures of statistical confidence. Similarly, qualitative information may be best interrogated by undertaking thematic analysis, coding and word frequency counts.

As such, any framework for research in this field must make appropriate use of qualitative and quantitative data and subjective and objective information. To this extent, it is prudent to determine a matrix of measures and methods prior to any investigation and for holistic analysis, and hence conclusions, to be formed from this process. There is significant scope for mixed methods approaches to be adopted in this domain. In particular, the repertory grid method (Easterby-Smith, 1980) is one such approach that permits qualitative and quantitative data to be gathered utilizing a range of capture methods, such as interviews, surveys and focus groups. This information can then be analyzed for statistically significant occurrences and patterns, allowing a balance to be struck between the amount of time required for capture and analysis of data and the validity and reliability of the findings. This would be particularly suitable for all subjective data that has to be gathered in any creativity and technology success measurement. Such a technique could then be complemented by the analysis of the objective business, technological performance, and societal data. Thus, an efficient framework should seek to use a range of data and information sources and combine them in a holistic and triangulated way to best determine the success of creative, technological collaborations.

Table 2 summarizes the key aspects are highlighted for future research into the success and impact of creative and technological collaborations:

*Table 2: Summary of Research Data Type and Information with respect to Success Domains*

| | **Quantitative** | **Qualitative** |
|---|---|---|

| | | |
|---|---|---|
| **Subjective** | • Business (human factors)<br>• Creativity and collaboration (clients) | • Creativity and collaboration (practitioners and professionals)<br>• Society (focused sample) |
| **Objective** | • Business (KPIs)<br>• Technology (performance)<br>• Technology (human evaluation) | • Technology (human evaluation) |

It is worth noting that the likelihood is that all such research will be undertaken in practice, in the real world and 'in the wild' and therefore it must be acknowledged that control of many extraneous variables will not be possible. This factor can be mitigated, in part, by seeking to obtain large sample sizes, where regression to the mean acts as a counter to any noise present in the data. Similarly, the adoption and pairing of quantitative data with qualitative permits triangulation and the opportunity for the researcher to conduct more focused investigative themes and inquiries.

## THE INTERNET AND ONLINE COLLABORATION

### Online multi-player gaming

The Internet is now ubiquitous and increasingly integrated into everyday activities such as work and leisure. Clark (1999) argued that one Internet year was equivalent to seven calendar years, and therefore the more significant the Internet became, the faster the processes and developments would take place. In addition to this potential offered by Internet facilitated Virtual Collaborations, especially the World Wide Web (Earnshaw *et al.* 2015), a wide variety of online gaming environments are available on the Internet, including science fiction, sports, superheroes and historical scenarios. Players can create characters that can travel in the game environment and interact with other characters or objects. Communication can be via text or voice commands. They can offer an environment for a single game, or a number of contests. Others offer a persistent environment that is permanently modified. Game play has also been used in simulation exercises for education and training courses, where the environment is designed to facilitate the development of particular sets of skills.

This raises the interesting question of what further developments may take place in online collaboration via the Internet that may have even greater effects than those already observed.

### Sharing and Collaboration: Online Libraries

Social media increase has led to increased capacity and opportunity for networking and information sharing in formal and informal ways and has helped enhance and augment the communication infrastructure in communities. This has led to a rise in educational offering courses enabling content from leading institutions worldwide to be accessed by anyone online, especially Massive Open Online Courses (MOOCs), providing increased opportunity for learning and knowledge acquisition (Earnshaw *et al.* 2015).

When this is combined with access to digital libraries of the kind facilitated by the Oxford/Google Digitization Project, there is significant potential for an open access world of information and learning. The project started in 2004 and was in partnership with major Universities in the USA such as Harvard, Michigan, Stanford, and New York Public Library. Out of copyright holdings have been scanned and are now freely available on the Internet for reading or downloading as PDF documents. They are also available as Google books via the Google books web site. There are ongoing legal issues with regard to the infringement of copyright matters for volumes where a copyright is still currently held. In addition, scanning processes have introduced some errors into the scanned documents that have not subsequently

been corrected. However, the project has made major archival documents available on a global basis, which previously would have required a visit to a major University library.

## BROADCASTING MEDIA AND INTERNET AS SECOND SCREEN

### User Scheduling and Control of Broadcast Content

Broadcasting media have well-established methodologies for generating content and distributing to viewers either via traditional broadcasting or via the Internet. The content can also be stored by users on servers and used to determine their own schedule for viewing the content, rather than having to comply with those of the broadcasters.

Viewers are also being given increasing interactive control of content in broadcast transmissions so that, for example, they can set up their own viewpoint for a sports event. The viewer is therefore moving from passive recipient to interactive user. Thus media is being increasingly customized and the consumer is invited to tailor it to their particular interests and requirements. The decreasing costs of technology enable users to transmit their content to the same fidelity standards as that of broadcasters. It is only a matter of time before they also have the required creative and production skills to generate the content to the same standards as well. Thus traditional broadcasters are looking to form partnerships with new media organizations and innovative content creators in order to preserve market share in an increasingly collaborative media environment in the future.

In addition, viewers now have their own capability for generating content, including commenting on the content they have already received via traditional means. Thus we are moving from a world of one to many broadcasting, to one of many to many.

### Crowd-Based Online Media

In the US Presidential elections of 2012 it was reported that the Obama campaign was more actively involved in social media than their competitors (Pew Research Center 2012). It also generated more responses from the public in terms of the sharing of information and comments on it.

Social media fills the gap left by broadcast and cable news. Gatekeepers and editorial bias in broadcasting influences what is included in television programmes and newspapers. Internet is peer-to-peer without any editorial filtering.

Can Facebook influence governments? The Arab Spring accomplished political change. The 2009 Green Revolution in Iran was an insurrection recorded on Twitter. Tufecki & Wilson (2012) analyze the use of social media in Egypt's Tahrir Square protest by means of over 1,000 interviews with protestors after the President resigned.

The study's findings included the following -

- Three-quarters of the Tahrir Square protestors interviewed were male. The female protestors tended to be younger, better educated and were more likely to have Internet access on their phone and at their home than the men.
- Of those interviewed, 52% had a Facebook profile and almost all used it for communication about the protests; only 16% had a Twitter account.
- Nearly half of participants (48.4%) first heard about the protests from face-to-face communications. *"Traditional mass media were far less important for [informing] people about the protest than were more interpersonal means of communication (face-to-face, telephone, or Facebook). Nearly half of participants (48.2%) engaged in citizen journalism, sharing video or photos of the protests. "The leading platform for producing and disseminating visuals was Facebook, used by about fully a quarter of the sample (25%), and phones were a distant second, used by 15%. These were not*

*mutually exclusive options; many who used their phones also used Facebook (72% of those who used their phone also used Facebook), presumably uploading videos and pictures taken on their phones to Facebook. About 5% of the sample used Twitter."*

- The vast majority of protestors actively used email, but relatively few of them used it to communicate about the protests. By contrast, few people first heard about the protests by text, but nearly half used texting to share information.
- The authors conclude*: "In the case of protests in Egypt, it appears that social networks, often mediated through the new online platforms in the emergent networked public sphere, played a crucial role. The high level of production and dissemination of multimedia content, undertaken by about half the sample, shows that it became difficult to suppress information about protests. Approximately half of our respondents were actively documenting and sharing images of the protests. If that proportion was applied to even the most conservative estimates of total participation in the Tahrir Square demonstrations, it becomes apparent that at least tens, if not hundreds of thousands, of people were documenting the protests — and were, de facto, functioning as citizen journalists"*

Earnshaw *et al.* (2015) report that similar developments in the fields of virtual environments have also changed the way that collaboration takes place in fields such as theatre rehearsal, orchestra rehearsal, dance rehearsal, and art installations, although latency effects are frequently a concern in such technologically mediated interactions (Friston and Steed 2014).

## CONCLUSION

The impact of creative collaboration presents an opportunity for significant rewards and impact on short and long-term scales. Technology has worked not only as an enabler for the creative sector but also as an opportunity for new kinds of collaborations and interactions. Crowd-accelerated innovation is facilitated by advancing technologies. In addition, the socio-cultural changes that mass media, always on/always connected communication, high speed Internet, and technologically driven consumer markets have produced increased public interest and expectation. The result is that many crowd-funded or crowd-sourced innovations are often technologically inclined themselves. Similarly, the computer and video games and Hollywood film industries have been transformed by the way creativity is executed.

In addition, there are changing trends in the use of social media over time driven by user preferences or what other people are perceived to be using. Greater use of video and live streaming is increasing relative to more static forms of communication. For instance, in Great Britain, 96% of 16 to 24 year olds; 88% of 25 to 34 year olds; and 83% of 35 to 44 year olds make use of social networking (Office for National Statistics 2017) whilst the use of the traditional postal system has continued to see a decline in use (Ofcom 2017). Although the television set continues to be the most popular device for watching live television broadcast, the smartphone and PC or laptop are the preferred devices for interacting with Facebook and YouTube (Ofcom 2017).

Whilst there is much opportunity for further technology-driven innovation and success, the next steps in fully utilizing the creative potential lies in the understanding, integration, and enhancement of creative teams working together over large distances, often bringing together different cultures and social contexts. Harnessing these global creative assets for the benefit of future environments, products and services in the artistic domain in more effective and efficient ways is a major challenge for the future.

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